

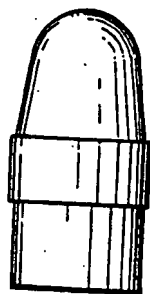
March 3, 1964

P. H. LANGE, JR., ETAL  
GALLERY BULLET

3,123,003

Filed Jan. 3, 1962

**FIG - 1**



**FIG - 2**



INVENTORS.  
PAUL H. LANGE, JR.  
OMER N. DEJARNETT  
BY *Thomas P. O'Hay*  
ATTORNEY

## GALLERY BULLET

Paul H. Lange, Jr., New Haven, Conn., and Omer W. De Jarnett, Alton, Ill., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia  
Filed Jan. 3, 1962, Ser. No. 164,157  
9 Claims. (Cl. 102-91)

This invention relates to novel formulations for use in the manufacture of bullets, and more particularly it is concerned with formulations which can be used in the preparation of a unique disintegrating gallery bullet.

In the production of bullets for use in shooting galleries, a primary consideration should be to prepare a bullet which disintegrates on the target without excessive splashback of bullet particles. Conventional lead bullets, while possessed of good ballistic properties, are not safe to use in such galleries because of the splashback of large lead particles from the target. Various other types of bullets have been designed in an effort to overcome these difficulties.

For example, U.S. Patents 2,105,528, 2,168,381 and 2,315,853 disclose the preparation of bullets which have been formulated by mixing lead with other metals such as zinc or copper or another compound such as iron oxide. These bullets, while much superior to plain lead bullets for use in shooting galleries, still do not disintegrate satisfactorily upon the target and a great deal of litigation has resulted from injuries caused by splashback of particles.

A recent U.S. Patent 2,995,090 has issued wherein gallery bullets have been prepared from iron particles which have been molded into a homogeneous body with the aid of a thermoplastic binder. These bullets are characterized by improved safety features since the tendency for large particles to spatter about upon disintegration has been reduced. However, since these bullets are much lighter than lead bullets, they must be fired at a much greater velocity in order to achieve the energy level of the lead bullets. As a result, an excessively loud noise level is associated with the use of these bullets, and this is an especially undesirable characteristic in enclosed shooting galleries.

Therefore the primary object of this invention is to prepare novel formulations which can be used in the production of a unique gallery bullet. A more specific object is to prepare formulations to be used in the production of a gallery bullet which has the good ballistic properties of a lead bullet without being subject to the dangerous spattering of lead particles inherent in many of the prior art gallery bullets.

Still another object of this invention is to prepare an improved gallery bullet which will not be characterized by an undesirably high noise level when fired. Other objects will be noted in or will be obvious from the following discussion.

These objects have been accomplished in accordance with the present invention. Novel formulations have been prepared which can be used to make gallery bullets possessing new and improved qualities. From these formulations a gallery bullet can be prepared which possesses the desirable ballistic characteristics of a conventional lead projectile and is not subject to dangerous back spattering. These novel formulations are comprised of lead particles, iron particles and a thermosetting resin which have been combined in certain preferred proportions. The bullets prepared from these formulations possess the strength to withstand shooting, have a relatively high density and furnish important safety features to the user. The resultant gallery bullets are also characterized by excellent disintegration properties, and there is no objectionable noise level when the bullets are fired.

FIGURE 1 is a side view of a bullet prepared from the formulations described herein.

FIGURE 2 is a sectional view of the bullet shown in FIGURE 1.

It has been found that for best results, a relatively coarse lead powder should be utilized in these novel formulations. It is preferred to use lead powder of such a size that a 2% maximum of such powder would be retained on a 40 mesh screen and a 65% minimum of such powder would be retained on a 100 mesh screen. There are several reasons for the preferential use of the aforementioned particle size. The use of such coarse particles is necessary to provide good feeding in tabletting presses. In addition, finer powders having much greater surface area are more affected by corrosion products on their surfaces. On the other hand if too coarse particles are used, the highly undesirable splashback problems may be again encountered.

It is known that lead powder is particularly susceptible to surface corrosion, and such corrosion prevents the development of full strength upon compaction by powder metallurgy techniques. The corroded particles will not adhere satisfactorily to each other because the corrosion products are refractory in nature. Therefore in order to prepare bullets of adequate strength, it is necessary to use lead particles in the tabletting process which are substantially free of surface corrosion products. Such lead particles may be prepared by removing corrosion products by pickling in suitable liquids and then using the freshly cleaned lead powder immediately in the manufacture of bullets. However, it has been found that the preferred manner of obtaining corrosion free lead powder is to use a commercial product known as oil-treated lead wherein lead particles are covered with oil immediately after being powdered. This treatment effectively preserves the surface of the lead powder from corrosion or oxidation products. The use of such treated lead powder in the formulations is entirely satisfactory in the preparation of the improved gallery bullets.

The formulation which has been found to be most desirable in preparing these unique disintegrating bullets is comprised of the following ingredients: 83 parts by weight of lead powder to 17 parts by weight of iron powder and 0.75 part by weight of a thermosetting resin. Successful gallery bullets have been made from formulations containing equal amounts by weight of lead and iron powders. However, in general, the preferred formulations include the following proportions of ingredients: iron—30 to 17 parts by weight, lead—70 to 83 parts by weight and thermosetting resin—0.1 to 1.0 part by weight.

The iron powder which can be used in these novel formulations is produced by the reduction process. For best results, the iron powder should be so sized that 98% will pass through an 80 mesh screen and 25-35% will pass through a 325 mesh screen.

Superior adhesion to the surfaces of the metal powders involved in the formulations is an important requisite of the thermosetting resins which can be used in the practice of this invention. It has been found that the use of epoxy resins in these formulations is particularly desirable. The commercially available materials of this class are usually derived from bisphenol A and epichlorohydrin although other chemicals may be used in the preparation of the epoxy resins. For example, bisphenol A may be replaced by other diphenols, glycols or even glycerine. Before curing, the desirable epoxy resins suitable for use in these formulations are viscous liquids or clear brittle solids having molecular weights from about 600 to 8000.

It has also been found that various polyesters and polyurethanes can be used as the required resins. Gallery

bullets possessing the desired characteristics have been prepared when these compounds have been utilized instead of epoxy resins in the metal powder formulations.

It is necessary that the resin in the final powder mix be in a solid non-tacky form before this mix is introduced into the tableting machine or caking and sticking of the powder mix will occur during this operation. Liquid resins can however be satisfactorily utilized if they are partially polymerized to a solid non-tacky state before this operation.

Usually the curing of such thermosetting resins is achieved by using a catalyst or hardener but satisfactory results have been obtained in the absence of these compounds. The preferred proportion of thermosetting resin is 0.75 part per 100 parts of metal powders. It has been found that a proportion as small as 0.10 part will yield bullets; the performance of these bullets however, is inferior to those of the preferred composition. It has also been found that a proportion as high as 1.0 part will yield bullets, but these bullets do not possess the desirable ballistic characteristics exhibited by those containing the preferred proportion.

In powder metallurgy, it is conventional to use a lubricant such as a metallic stearate to cause the powdered metal to flow and compact satisfactorily. However it has been found that with the use of oil-treated lead powder, no other lubricant is required to obtain satisfactory flow of the powdered metals. If desired a metallic stearate such as lithium stearate may be used as a lubricant in the proportion of 0.01 to 0.5 part per 100 parts of powdered metal.

Some typical preparations of gallery bullets involving the use of these novel formulations are herein described.

#### Example 1

| Formulation:                                     | Percent by wt., parts |
|--|-----------------------|
| Lead powder, Type 40 B, oil-treated, Glidden Co. | 83                    |
| Iron powder, Ancor 80 <sup>1</sup>               | 17                    |
| Epon 1004 <sup>2</sup>                           | 0.75                  |

<sup>1</sup> Obtained from Hoeganes Sponge Iron Corporation.  
<sup>2</sup> "Epon" is a trademark for condensation products of epichlorohydrin and bisphenol-A. Obtained from Shell Chemical Corporation.

The iron powder and solid epoxy resin were blended in a double arm type blender for 15 minutes above the melting point of the resin (95-100° C.). The resulting mix was cooled and crushed in the same blender and then ground to pass through a 30 mesh screen.

Then the oil-treated lead was added to the iron-resin mix, and the entire mixture was blended and ground to pass through a 30 mesh screen. The powder mix was then compacted into bullets in a rotary tableting press. The bullets were cured for 3 hours at 300° F., tumbled to remove flash and then loaded in the usual manner.

#### Example 2

| Formulation:                                     | Percent by wt., parts |
|--|-----------------------|
| Lead powder, Type 40 B, oil-treated, Glidden Co. | 83                    |
| Iron powder, Ancor 80                            | 17                    |
| Epon 828, Shell Chemical Corporation             | 0.75                  |

The liquid epoxy resin was mixed with metaphenylene-diamine (13% by wt. of resin) and the mixture was warmed and stirred above the melting point of the diamine (ca. 63° C.).

This mixture, while in a liquid form, was stirred with the iron powder and left at room temperature for a period of about twenty-four hours at which point the solid mixture was no longer tacky. The mix was then ground to pass through a 30 mesh screen.

Then the oil-treated lead was added to the iron-resin mix, and the entire mixture was blended and ground to pass through a 30 mesh screen. Bullets were prepared from this mixture in the same manner as in Example 1.

#### Example 3

| Formulation:                                     | Percent by wt., parts |
|--|-----------------------|
| Lead powder, Type 40 B, oil-treated, Glidden Co. | 83                    |
| Iron powder, Ancor 80                            | 17                    |
| Estane 5740X2 <sup>1</sup>                       | 0.75                  |

<sup>1</sup> This is a polyurethane obtained from the B. F. Goodrich Chemical Company. It is made with diphenylmethane-p,p'-disocyanate, adipic acid and butanediol-1,4.

The Estane was dissolved in 10 cc. of methyl ethyl ketone by refluxing on a steam bath. Then 0.024 part of dicumyl peroxide and the iron powder were added to the solution, and the ketone was driven off on a steam bath. The resulting mix was ground to pass through a 30 mesh screen.

Then the oil-treated lead was added to the iron-resin mix, and the entire mixture was blended and ground to pass through a 30 mesh screen. Bullets were prepared from the mixture in the same manner as in Example 1.

#### Example 4

| Formulation:                                     | Percent by wt., parts |
|--|-----------------------|
| Lead powder, Type 40 B, oil-treated, Glidden Co. | 83                    |
| Iron powder, Ancor 80                            | 17                    |
| Atlac 382 <sup>1</sup> styrene monomer           | 0.75                  |

<sup>1</sup> Atlac is a trademark for polyester resins prepared by reaction of a bisphenol with unsaturated compounds such as fumaric or maleic anhydride. Product obtained from Atlas Powder Company.

Equal amounts (0.375 part by weight) of Atlac 382 and styrene monomer were stirred together until a clear solution was obtained, and then 2% of benzoyl peroxide (based on total weight of resin and styrene) was added and stirred. The iron powder was added and blended, and the resulting mix was allowed to stand at 160° F. for two hours. At the end of this period, the solid mix was non-tacky, and it was ground to pass through a 30 mesh screen.

Then the oil-treated lead was added to the iron-resin mix and the entire mixture was blended and ground to pass through a 30 mesh screen. Bullets were prepared from this mixture in the same manner as in Example 1.

#### Example 5

| Formulation:                                    | Percent by wt., parts |
|---|-----------------------|
| Lead powder, Type 40B, oil-treated, Glidden Co. | 83                    |
| Iron powder, Ancor 80                           | 17                    |
| Plaskon 941 <sup>1</sup>                        | 0.75                  |

<sup>1</sup> A polyester resin prepared by reaction of a diol and a dibasic acid and containing styrene monomer. Obtained from Allied Chemical Corporation.

To the Plaskon 941 was added 2% by weight of benzoyl peroxide with stirring. The iron powder was then added with stirring; and the mixture was allowed to stand at 160° F. for two hours. At the end of this period, the solid mix was non-tacky, and it was ground to pass through a 30 mesh screen.

Then the oil-treated lead was added to the iron-resin mix and the entire mix was blended and ground to pass through a 30 mesh screen. Bullets were prepared from this mixture in the same manner as in Example 1.

The bullets prepared in these experiments possess the good ballistic characteristics of lead bullets and are safe to use in shooting galleries since the dangerous back spattering of particles has been eliminated. Furthermore the use of these bullets is not accompanied by an objectionable noise level.

What is claimed is:

1. A formulation suitable for preparing a disintegrating gallery bullet by powder metallurgy techniques comprising a mixture of 70-83 parts by weight of lead powder the surface of which is substantially free of corrosion and oxidation products, 30-17 parts by weight of iron

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powder and 0.1-1.0 part by weight of a thermosetting resin.

2. The formulation of claim 1 wherein said resin is an epoxy resin having a molecular weight from about 600 to 8,000.

3. The formulation of claim 1 wherein said resin is selected from the group consisting of a polyester resin and a polyurethane resin.

4. A formulation suitable for preparing a disintegrating gallery bullet by powder metallurgy techniques comprising a mixture of

(a) 70-83 parts by weight of oil-treated lead powder, said lead powder particles being so sized that a 2% maximum of said powder would be retained on a 40 mesh screen and a 65% minimum of said powder would be retained on a 100 mesh screen, and

(b) 30-17 parts by weight of iron powder, said iron powder particles being so sized that 98% of said powder would pass through an 80 mesh screen and 25-35% of said powder would pass through a 325 mesh screen, and

(c) 0.1-1.0 part by weight of a thermosetting resin.

5. The formulation of claim 4 wherein said resin is an epoxy resin having a molecular weight from about 600 to 8,000.

6. The formulation of claim 4 wherein said resin is selected from the group consisting of a polyester resin and a polyurethane resin.

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7. A formulation suitable for preparing a disintegrating gallery bullet by powder metallurgy techniques comprising a mixture of 83 parts by weight of lead powder the surface of which is substantially free of corrosion and oxidation products, 17 parts by weight of iron powder and 0.75 part by weight of an epoxy resin having a molecular weight of from about 600 to 8,000.

8. A disintegrating gallery bullet comprising a compacted mixture of 70-83 parts by weight of lead powder the surface of which is substantially free of corrosion and oxidation products, 30-17 parts by weight of iron powder, and 0.1 to 1.0 part by weight of a thermosetting resin selected from the group consisting of an epoxy resin having a molecular weight of from about 600 to 8,000, a polyester resin and a polyurethane resin.

9. A disintegrating gallery bullet comprising a compacted mixture of 83 parts by weight of oil-treated lead powder, 17 parts by weight of iron powder and 0.75 part by weight of an epoxy resin having a molecular weight of from about 600 to 8,000.

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